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NATIONAL BUREAU OF STANDARDS

Technical News Bulletin

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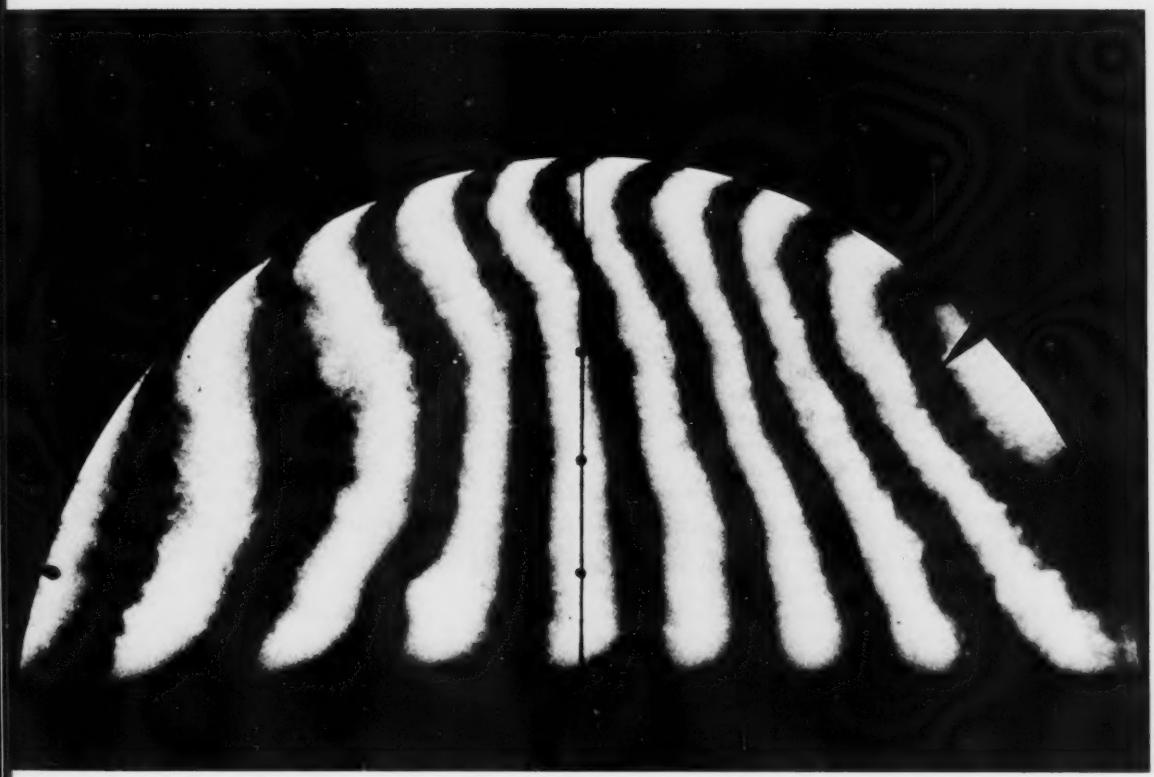

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NATIONAL BUREAU OF STANDARDS

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U.S. DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary

NATIONAL BUREAU OF STANDARDS
L. M. Branscomb, Director

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COVER: Typical fringe pattern obtained with an NBS-developed Kösters-prism interferometer. The instrument is practical for measuring index gradients in both large and small optics with good precision. *(See p. 219.)*

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology
- Center for Radiation Research
- Center for Computer Sciences and Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of NBS.

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A Kösters prism, shown in its mount, is an integral part of the versatile interferometer.

VERSATILE INTERFEROMETER DEVELOPED

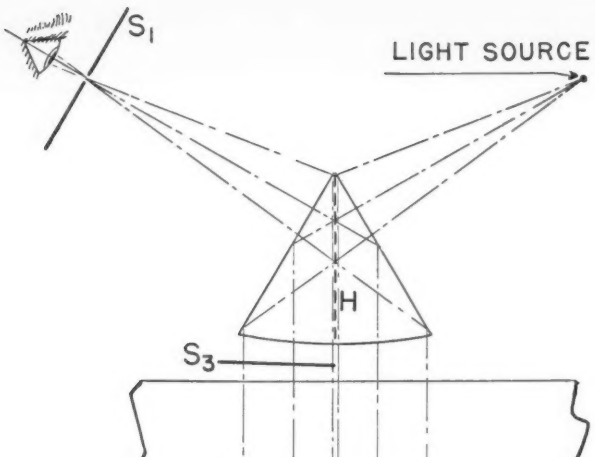
ALTHOUGH INTERFEROMETERS HAVE BEEN IN USE for many years, they are generally impractical for measuring homogeneity of large optics.

In an attempt to overcome this problem, J. B. Saunders of the NBS Institute for Basic Standards has developed a Kösters-prism interferometer [1] that is quite practical for measuring refractive indices and thickness gradients in both small and large optics. The interferometer is relatively free from vibration problems, and thermal gradients are reduced to a minimum by confining the two component beams of light to a small area. Scanning allows large specimens to be measured.

The interferometer is based on the same principle that is used in the Twyman-Green interferometer,[2] in which refractive indices and thickness gradients are calculated from two sets of interference fringes, one produced by light transmitted through the specimen and the other by light reflected from its two surfaces. It has the advantages, however, of fewer adjustments and the ability to evaluate large optics.

The main components of the NBS interferometer are a light source, Kösters prism, mirror, and three screens. The light source may be either a continuous emission laser or a highly monochromatic spectral source, such as that provided by a krypton-86 or mercury-198 lamp. If a laser is used, a short focus, single element, plano-convex lens that has its axis slightly tilted relative to the principal ray provides adequate divergence and sufficient freedom from unwanted interference fringes.

The prism is composed of two components cemented together to form an approximately triangular prism (the side that forms the base is spherical).



Drawing of NBS-developed interferometer for measuring refractive index and thickness gradients in both small and large optics.

The prism serves as: (1) a collimator lens, (2) a beam divider for dividing the beam twice, (3) two mirrors for deflecting the transmitted and reflected beams to a common direction, (4) a near perfect compensator so that white light interference can be used if desired, and (5) a collector lens.

In operation, the single beam of light from the source is divided into two beams by the beam divider. When unobstructed, each of these beams is incident on the two optical surfaces of the specimen and the mirror, M. Therefore, three components of each of the two beams return to the prism. These six beams are again divided by the beam divider into two components each. One set is transmitted toward the observer and the other set is returned toward the source. If the observer receives the six beams that are transmitted toward him, he sees a complex interference pattern that is useless for a measurement.

To obtain only the transmission fringes, a pinhole in a screen, S_1, conjugate to the source, is adjusted to obstruct light reflected from the specimen surfaces and to transmit that from the mirror.

The reflection fringes are made visible by intercepting the light to M with another screen, S_2, intercepting one of the beams from the prism with a third screen, S_3, and removing screen S_1.

The specimen is mounted so that it can be moved along a straight line normal to the dividing plane, along a set of ways. The set of ways has a scale attached that permits the sample to be moved equal intervals. The specimen is first scanned for observations of the orders of interference of the transmission fringes. The screens are then adjusted and observations of reflected fringes are made at the same points.

The only adjustments required for the interferometer, other than those made invariant by cementing the prism components together, are positioning the light source and mirror relative to the prism. The source should be located near the focal plane of the prismatic lens formed by the base of the prism so as to collimate the two light beams (one from each of the two prism components) in the specimen area of the interferometer. The source should also be adjusted so that the two component beams (reflected and transmitted by the beam divider) are parallel to the beam dividing plane.

The only critical adjustment of the mirror is positioning it about an axis parallel to the vertex of the prism. This adjustment, which can be controlled by a single screw that rotates the mirror relative to the prism assembly, controls the width of the transmission fringes.

If the surfaces of the specimen are adjusted to be approximately normal to the incident light, the width of the reflection fringes depends only upon the refractive index and angle between the two reflecting surfaces of the specimen.

The angle between the two surfaces of the specimen should form a 3 to 15 second wedge, so that the two component beams reflected from them will form interference fringes of suitable widths for accurate measurements. The two surfaces should also be flat to within about 4 parts per million to avoid excessive variation in fringe width.

In an NBS experiment to evaluate the instrument, two different interferometers of this type were used to measure index gradients at 18 equally spaced points along the diameter of a fused quartz disk, 3/4-inch thick and 16 inches in diameter. The average difference between the two sets of measurements was 8×10^{-7}. The maximum difference was 27×10^{-7}. These values are believed to represent the accuracy obtainable with the instrument.

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[1] Saunders, J. B., **An interferometer for measuring gradients in both refractive index and thickness of large or small optics**, J. Res. Nat. Bur. Stand. (U.S.), **73C**, Nos. 1 and 2 (Jan.–June 1969).

[2] Candler, C., **Modern Interferometers**, p. 143 (Hilger & Watts Ltd., Hilger Div., London England, 1951).

JOINT NBS-SAMA RESEARCH PROGRAM

Ion-Selective Electrodes To Be Studied

A TWO-YEAR RESEARCH PROGRAM on ion-selective electrodes has recently been initiated at the Bureau in conjunction with the Scientific Apparatus Makers Association (SAMA). The purpose of the program is to standardize techniques and prepare high-quality Standard Reference Materials (SRM's) that will permit an increased use of ion-selective electrodes.

The research work will be performed by Bert R. Staples of the Analytical Chemistry Division of the NBS Institute for Materials Research, under the direction of John K. Taylor and Richard A. Durst, also of the Analytical Chemistry Division. The long-range goal of the program is the preparation, certification, and issuance of SRM's for standardizing ion-selective electrodes. The leading problems to be tackled in this program are:

1. Definition of ionic activities in reference solutions suitable for the standardization of the ion-selective electrodes now commercially available.
2. Establishment of a self-consistent set of activity scales for these ions.
3. Examination of ionic activities in pure solutions of completely ionized sodium, calcium, chloride, and fluoride salts in light of electrode response.
4. Examination of methods for obtaining activity coefficients for lead, copper, and other metallic ions, possibly using perchlorate salts.

Seven SAMA member companies have contributed to a research fund from which quarterly grants will be made to the Bureau. The NBS Analytical Chemistry Division will provide matching funds to support one scientist full-time on the project. The firms sponsoring this joint research effort are: Beckman Instruments, Inc., Fullerton, Calif.; Corning Glass Works, Scientific Instruments Department, Medfield, Mass.; The Foxboro Company, Foxboro, Mass.; Leeds & Northrop Co., North Wales, Pa.; Orion Research, Inc., Cambridge, Mass.; The Perkin-Elmer Corp., Coleman Instruments Division, Maywood, Ill.; and Photovolt Corp., New York, N.Y.

The joint research effort is a special project of the SAMA Analytical Instrument Section's Task Group on Ion Selective Electrodes. This group was organized by SAMA to prepare industry recommendations for terminology and test procedures for ion-selective electrodes.

BENDER ELECTED JILA CHAIRMAN

PETER L. BENDER HAS BEEN ELECTED CHAIRMAN of the Joint Institute for Laboratory Astrophysics (JILA) succeeding Lewis M. Branscomb, the new NBS Director. Dr. Bender is widely known for his work on the use of lasers for precise measurement and for his studies of fundamental constants. A senior staff member of the NBS Laboratory Astrophysics Division, Dr. Bender is also Adjoint Professor in the University of Colorado Department of Physics and Astrophysics.

JILA was established in 1962 as a collaborative effort of the University of Colorado and the Bureau. Its purpose is to further laboratory and theoretical research and graduate-level training in physical processes of astrophysical importance. Dr. Bender's election by the Fellows of JILA to serve until January 1971 was announced by Dr. Branscomb, whose resignation as Chairman followed his nomination by President Nixon as the sixth NBS Director.

In announcing Dr. Bender's election, Dr. Branscomb said, "the Chairman of the Joint Institute for Laboratory Astrophysics serves his colleagues in one of the most scientifically exciting laboratories in the Nation, combining talents of both Government and university scientists, in a laboratory where the work provides training for 50 graduate students. The Institute produces invaluable knowledge in many fields of science. Dr. Bender's international professional standing and his broad interests, ranging from geophysics to astronomy and the study of atoms, make him ideally qualified to lead the Institute."

FLUORINE STUDIED

FLUORINE—ONE OF THE MOST REACTIVE ELEMENTS—forms compounds with all other elements, with the possible exception of the lighter rare gases. Many of its compounds are uniquely resistant to both thermal and chemical attack. Thus fluorine plays an important role in numerous aspects of man's environment and technology including very high temperature flames, rocket propellants, special lubricants, and polymers.

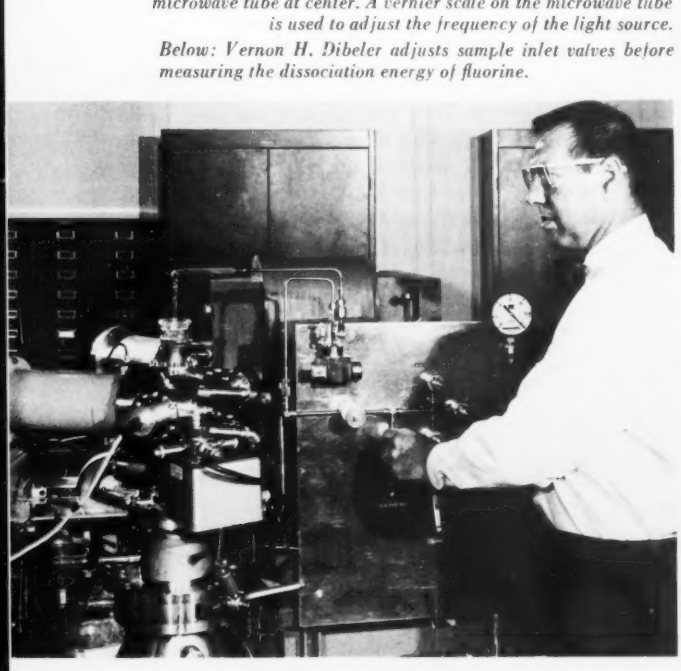
At the NBS Institute for Materials Research, fluorine's thermochemical properties, which are closely associated with its highly reactive nature, are being studied. Experiments designed to investigate these properties for both fluorine (F_2) and hydrogen fluoride (HF) molecules with an accuracy greater than previously obtained have been carried out by V. H. Dibeler, J. A. Walker, and K. E. McCulloh [1] with support from the Atomic Energy Commission.

Among the unique properties of fluorine compounds are their very large negative heats of formation; that is, considerable energy is evolved when they are formed from their elements. On the other hand, a relatively small amount of energy is required to produce fluorine atoms from the ordinary form of fluorine, the gaseous diatomic molecule. Precisely how much energy is evolved in these processes is an important question frequently asked by scientists and engineers when planning experiments, predicting properties of unfamiliar molecules, designing a rocket propulsion system, or considering the feasibility and commercial value of a new chemical process. For example, in the last forty years numerous values ranging from 63 kcal mol^{-1}, or higher, to 30 kcal mol^{-1}, have been proposed for the dissociation energy of fluorine. A much smaller range has been reported for HF.

The apparatus used in this work to obtain mass spectra and photoionization yield curves for the ions of F and HF includes a discharge lamp, a vacuum ultraviolet monochromator, an ionization chamber, and a mass spectrometer. The discharge lamp produces photons that pass through differential pumping slits and are diffracted by a grating, much as a prism disperses visible light. Photons of the wavelength selected by rotating the grating enter an ionization chamber through a slit, ionizing or dis-

Right: In an experiment measuring the dissociation energy of fluorine, James Walker opens the gas inlet valve to the light source. The glass lamp (above center) extends horizontally from the microwave tube at center. A vernier scale on the microwave tube is used to adjust the frequency of the light source.

Below: Vernon H. Dibeler adjusts sample inlet valves before measuring the dissociation energy of fluorine.



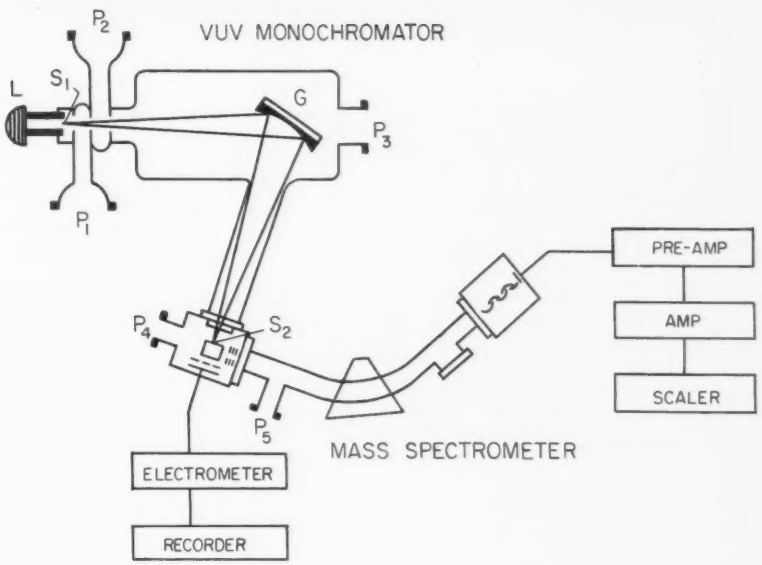


Diagram of apparatus used to measure the heat of formation of HF, the dissociation energy of F_2, and the photoionization energy of F. Photons from lamp (L) pass through slit (S_1) into monochromator. They strike grating (G) and interact with sample gas in ionization chamber after passing through slit (S_2). A mass spectrometer analyzes the ions formed by the process. Vacuum pumps (P_{1-5}) maintain a pressure differential between the lamp and the spectrometer.

sociating the gas molecules under study. The ions are identified by a mass spectrometer and are counted separately by a detector and an amplifier-scaler system. Data are recorded as graphs of ion counts per unit of photon intensity versus wavelength.

The monochromator provides a means of specifying the particular wavelength (energy) of the photon beam, in much the same way as the mass spectrometer unambiguously identifies the ion products. Thus, although many attempts have been made to measure accurately the dissociation energies of these molecules, the NBS measurements represent the first measurements based on unequivocal observation of dissociation.

The NBS scientists first studied the fluorine ionization processes,

$$F_2 + h\nu \rightarrow F_2^+ + e,$$
$$F_2 + h\nu \rightarrow F^+ + F + e, \text{ and}$$
$$F_2 + h\nu \rightarrow F^+ + F^-;$$

where the symbol, $h\nu$, represents the energy of the photon interacting with the molecule. As a result, a value of 1.34 eV, or 30.9 ± 0.7 kcal mol^{-1} was obtained for the dissociation energy of the fluorine molecule into two neutral atoms. This is markedly lower than the earlier values and, if agreed upon as a standard value, has a major affect on calculations of bond dissociation energies in all fluorine-containing compounds.

One of the most important of these is the simple molecule, hydrogen fluoride. Thermochemists consider that the heat of formation of gaseous HF is well established despite certain troublesome chemical and physical properties of this molecule. Careful measurements enabled the NBS investigators to also measure the photon impact processes:

$$HF + h\nu \rightarrow HF^+ + e,$$
$$HF + h\nu \rightarrow H^+ + F + e, \text{ and}$$
$$HF + h\nu \rightarrow F^- + H^+;$$

obtaining a value of 5.74 eV, or 132.4 kcal mol^{-1} for the energy required to dissociate the HF molecule into two neutral H and F atoms. Combining this value with the dissociation energy of fluorine and the accepted value for the dissociation energy of hydrogen gas gives the heat of formation, $\Delta Hf_0^\circ(HF) = -2.83$ eV, or -65.3 ± 0.7 kcal mol^{-1}. The latter is in good agreement with the value of -64.8 kcal mol^{-1} presently accepted by major scientific groups throughout the world and thus supports the new value for the dissociation energy of fluorine.

Although the effect of the new value for the dissociation energy of fluorine on such an important application as rocket fuels has not yet been fully evaluated, and may, in fact, not be large, there is no doubt that major changes will appear in the calculation of the bond dissociation energies of molecules containing one or more fluorine atoms. In addition, the unequivocal nature of the measurements gives a greater confidence to theoretical as well as experimental research in this field and is expected to lead to a better understanding of the observed unique properties of the many fluorine-containing compounds in use throughout science and industry.

[1] Dibeler, V. H., Walker, J. A., and McCulloh, K. E., Dissociation energy of fluorine, J. Chem. Phys. 50, No. 10, 4592 (May 1969).

AVERAGING THE PEAK AMPLITUDES OF PULSES

Instrumentation for Evaluating Magnetic Tape

In 1967 the NBS Center for Computer Sciences and Technology undertook to develop performance standards for magnetic recording tape and, ultimately, to supply samples of tape for use as a reference standard. To accomplish this NBS engineers Sidney Geller and Paul Mantek, working with Norman Cleveland, a Research Associate [1] from the International Business Machines Corp., developed a signal amplitude measurement system. In the course of this development they found that they needed a way of measuring the average amplitude of a train of equispaced signal pulses. Mr. Geller developed the concept and the circuitry for this purpose; they were used in the tape performance research and in the instrumentation adopted for tape evaluation. This enabled the Bureau to issue Standard Reference Material 3200, Secondary Standard Magnetic Tape—Computer Amplitude Reference, supplied with a description of the circuitry and procedures for its use.[2]

Magnetic Tape Performance

Magnetic tape, now used to record statistics on every man, woman, and child in the United States, has been continuously improved by the efforts of its manufacturers, but the only reference standards available for production control have been those maintained by the individual manufacturers. Generally, tape to be tested is erased and a string of repetitive data in the form of equispaced pulses is recorded on its surface. When the tape is "read," each transition between the two magnetic states generates a pulse as it passes across the read head's gap. The average of these pulse peaks over a finite time is a good indicator of the tape's data-storing efficiency. Because of differences among standards, however, tape and equipment thought to meet specifications of its manufacturer and user sometimes have been found to perform marginally.

The Bureau began the present program of magnetic tape performance measurement at the request of Federal agencies procuring magnetic tape, manufacturers and industrial users of computer tape and equipment, and standards organizations (ISO and USASI).[3] It was soon found that all existing standards specified an acceptable pulse readout amplitude (for specified recording current), referred to by such designations as "average peak volts," "average peak output," and "average pulse amplitude." It was felt that an accurate method for measuring the average signal amplitude of a sample containing a specific number of pulses should be devised for the NBS reference tape measurement system.

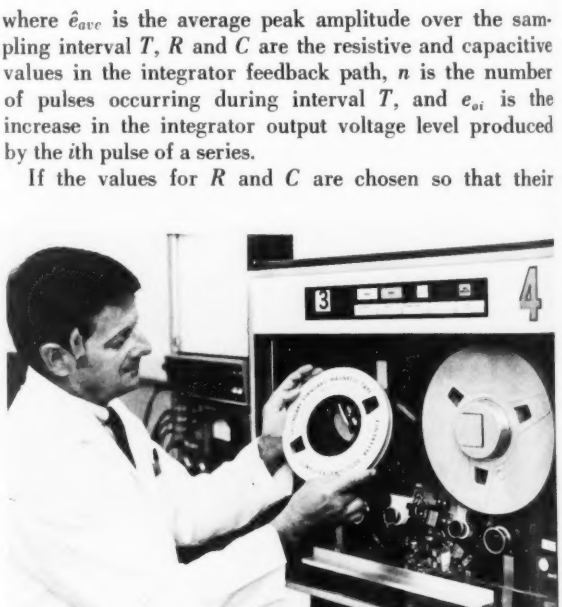
Averaging Pulse Heights

Mr. Geller approached the need for a new measurement technique by producing a relevant mathematical relationship and then designing electronic circuitry for performing the required functions. A mathematical formula gives the output voltage from a linear integrator that is fed an input of equispaced pulses of varied amplitude:

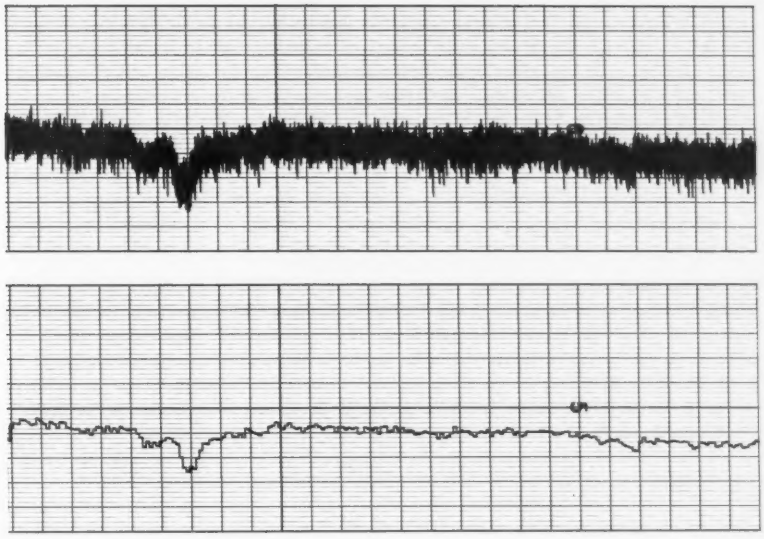
$$\hat{e}_{ave}=\frac{RC}{T}\sum_{i=1}^{n}e_{oi},$$

where $\hat{e}_{ave}$ is the average peak amplitude over the sampling interval T, R and C are the resistive and capacitive values in the integrator feedback path, n is the number of pulses occurring during interval T, and e_{oi} is the increase in the integrator output voltage level produced by the ith pulse of a series.

If the values for R and C are chosen so that their



Norman Cleveland threads a reel of SRM 3200 onto a tape transport.



The peaks of a series of pulses, obtained by reading a series of binary "ones" recorded on magnetic tape, are recorded on the upper stripchart. Averages of these peaks over 0.27-second intervals (below) were obtained by circuitry devised at the Center.

product equals the sample duration, T, then $\frac{RC}{T}=1$, and the integrated voltage is equal to the average of the peak values of the pulses sampled. The NBS circuitry does this by integrating pulses that are held at the level of each peak for an entire interval. This is made possible by using a peak detector to trigger a generator which produces strobe, or timing, pulses coincident with the input pulse peaks. Both signal and strobe pulse-trains are fed to a sample-and-hold circuit. On receiving a strobe pulse, the circuit clamps its output at the instantaneous signal level and holds it until the next strobe pulse is received. Each following strobe pulse shifts the sample-and-hold output to the level of the successive input peak.

The steplike output of the sample-and-hold circuit is fed to the linear integrator, causing its output to rise at a rate determined at each instant by the amplitude level of the sample-and-hold signal. The integrator then yields the average value of the measured signal at the end of period T.

A second strobe generator controls the average sampling periods, T, to be 0.260 second in length and clears the integrator at the end of each T in order to start integrating for the next average value. This strobe also sets a second sample-and-hold circuit to the average peak value cleared at the end of each T, which it holds for use during the following interval T. These values are presented at a rate of about four per second and can be recorded by a chart recorder or a voltmeter producing a digital printout.

Evaluating the Tape

The signal peak averaging circuitry is easily calibrated before use by injecting a stable, accurately known d-c voltage into the linear integrator, in place of the signal from the first sample-and-hold output. The average peak output should be equal to the d-c value; the R value in the integrator circuit is adjusted to obtain this readout.

Tape to be evaluated is first degaussed by a bulk eraser and then binary "ones" are recorded on all channels in the NRZI recording mode. The write-head current is automatically maintained at the current level producing a peak saturated signal on the reference tape at the frequencies of interest. The tape is transported at 112.5 inches per second; a write frequency of 180 kHz produces data at a density of 3600 bits per inch on the tape.

After being recorded, tracks 2, 5, and 8 of the tape are read on the same pass and both the peak amplitude and the average peak amplitude of the signal are simultaneously measured and charted.

A description of the entire NBS measurement system accompanies each reel of ½-inch wide SRM 3200 reference standard magnetic tape. The user can assemble his own instrumentation and check its operation with the SRM 3200.

[1] Research associate program expanded, NBS Tech. News Bull. **51**, 68–69 (April 1967).

[2] Information Processing Notes: New reference tape standard, NBS Tech. News Bull. **53**, 118 (May 1969).

[3] The International Organization for Standardization and the USA Standards Institute.

POSTDOCTORAL RESEARCH ASSOCIATES

POSTDOCTORAL RESEARCH ASSOCIATESHIPS for 1969–70 have been awarded to eighteen young men and women enabling them to further their studies at the Bureau. The awarding of these research associateships is part of the postdoctoral programs sponsored each year by the National Research Council, the National Academy of Sciences, the National Academy of Engineering, and NBS. The program, now in its 15th year, includes thirteen Government facilities* besides NBS, which is one of the oldest and largest program participants.

These scientists, who have recently earned their doctoral degrees, were selected on the basis of outstanding ability in their specific fields of interest.

Since the Bureau holds the unique position of being the Nation's central laboratory for physical measurement, working here will provide these young Ph.D.'s the opportunity to expand their horizons in the realm of basic research, and gain an insight to the problems of industry. The one or two years of postdoctoral research at NBS will not only assist the Ph.D. in establishing himself professionally, but will also enhance his value as a potential faculty member, Government research scientist, or industrial scientist.

The 18 Postdoctoral Research Associates selected to work at NBS this year are listed below along with their university and NBS adviser. A brief description of their proposed work is also given.

Gordon W. Day (Univ. of Illinois) proposes to search for new materials that are radiation sensitive in the long wavelength region under the influence of a strong d-c electric field. Such studies may assist in developing new photodetector mechanisms. (L. M. Matarrese, adviser; Boulder).

William L. Greer (Univ. of Chicago). Dr. Greer is interested in a disordered crystal as an example of a many-body system. He will evaluate transport properties of disordered crystals using the Kubo-Green formalism rather than the older formalism based on the Boltzmann equation. This research is directed toward an improved basic understanding of the transport properties of disordered crystals. (R. J. Rubin, adviser; Gaithersburg).

*Agricultural Research Service, Air Force Systems Command, Bureau of Mines, Environmental Science Services Administration, Food and Drug Administration, Fort Detrick, Naval Bureau of Medicine and Surgery, Naval Electronics Laboratory Center, Naval Ordnance Laboratory, Naval Postgraduate School, Naval Research Laboratory, Naval Weapons Center, and U.S. Geological Survey.

William M. Haynes (Univ. of Virginia) will test the validity of transport property theories by making accurate and wide-range viscosity measurements on gaseous and liquid fluorine. (D. E. Diller, adviser; Boulder).

Elizabeth Jean Jacob (Univ. of Michigan) will be studying the microwave spectra of hydrocarbons and simple derivatives with the aim of making accurate measurements of their molecular structure. (D. R. Lide, adviser; Gaithersburg).

Paul S. Julienne (Univ. of North Carolina) will use the quantum theory of scattering to investigate the theory of collisional quenching of atomic or molecular excited species in a gas. (F. H. Mies, adviser; Gaithersburg).

Ernest G. Kessler (Univ. of Wisconsin) proposes a method for obtaining absolute wavelength measurements of the spectrum of He II that will yield a more precise value for the Rydberg constant. (W. C. Martin, adviser; Gaithersburg).

Carl A. Kocher (Massachusetts Institute of Technology) proposes to explore the possibility of an existing deviation in the Josephson frequency. This may appear in radiation emitted by superconducting tunnel junctions. (R. H. Kropschot, adviser; Boulder).

David E. Kranbuehl (Univ. of Wisconsin). Dr. Kranbuehl proposes two studies that would provide needed information in the analysis of polymer chains. These proposals include a computerized investigation of the dynamics of molecular chains, and an extension of the small molecular rotational diffusion equations to larger systems. (P. Verdier, adviser; Gaithersburg).

Michael S. Kurylo (Catholic Univ.). Energy surface calculations proposed by Dr. Kurylo can contribute vital information to justify present reaction rate theories. In addition, the deactivation of the same investigated species will yield information on basic energy transfer. (J. R. McNesby, adviser; Gaithersburg).

Russell L. Merris (Univ. of California). Dr. Merris will continue work initiated in his doctoral thesis on the investigation of the coefficients of the matrix polynomial $K(A+B)$. He proposes answering such questions as "What is its rank?", "What is its determinant?", and "What are its elementary divisors?" (M. Newman, adviser; Gaithersburg).

William C. Mitchell (Washington Univ., Mo.) will investigate theoretically the transient response of superfluid helium to heat pulses. He is interested in deriving

quantum hydrodynamic equations from nonequilibrium statistical mechanics. This fundamental work will contribute to an understanding of the use of helium for cooling at temperatures below 2.19 K. (B. Robertson, adviser; Gaithersburg).

Rogers W. Redding (Vanderbilt Univ.) will determine the behavior of the rotational levels of an asymmetric AB_2 molecule (unequal bond lengths). He hopes to construct a correlation diagram connecting rotational levels for zero barrier (equal bond lengths) with those in the high barrier case to give a pictorial representation of the work. (J. T. Hougen, adviser; Gaithersburg).

Gregory J. Rosasco (Fordham Univ.) proposes to study, by light scattering experiments, second order phase transitions on lambda-type critical points of one or more perovskite materials. The use of Brillouin spectroscopy will allow further information to be obtained concerning fluctuations and/or domain motion in crystals. (H. P. R. Frederikse, adviser; Gaithersburg).

Isaac C. Sanchez (Univ. of Delaware). The structure and morphology of bulk polymers can best be understood through a knowledge of the properties and behavior of the constituent crystalline polymers. To this end Dr. Sanchez will be calculating the growth rate, thickness of the lamella formed, and the purity of polymer crystals as a function of such parameters as supercooling. (E. A. DiMarzio, adviser; Gaithersburg).

LeRoy W. Schroeder (Northwestern Univ.) suggests studying such crystals as $NaHF_2$, PH_4I and $(NH_4)_2SnBr_6$ by neutron diffraction, inelastic neutron scattering and other spectroscopic techniques. He hopes to gain a better understanding of interatomic and intermolecular forces in these solids and their relation to the crystal structure and hydrogen bonding. (J. J. Rush, adviser; Gaithersburg).

Carl C. Semmelroth (Univ. of Michigan) will determine the influence of color contrast for varying sizes and colors of test spots and surrounds. This may help to provide a more accurate method for quantitatively predicting color perceptions. (D. B. Judd, adviser; Gaithersburg).

Kenneth G. Sharp (Rice Univ.). The low temperature chemistry of high temperature species offers considerable promise for synthesis of novel materials. Dr. Sharp proposes to investigate this low temperature, "reactive matrix" chemistry for a number of molecules now known only at high temperature. (T. D. Coyle, adviser; Gaithersburg).

Selden L. Stewart (Univ. of Texas) proposes to develop an overall data structure that would be flexible enough to handle many kinds of scientific information in a computer environment and also to retain the relationships among data. This would be a powerful tool in augmenting the value of information storage and retrieval systems. (S. J. Tauber, adviser; Gaithersburg).

BUILDING-COST SYSTEMS PROJECT

TAKING SOME OF THE UNCERTAINTY OUT of Government construction is the aim of an NBS program on Cost Analysis/Cost Synthesis System for Construction Control. The program is supported by five Federal agencies that have continuous building programs—the General Services Administration; the Veterans Administration; the Post Office Department; the Department of Health, Education, and Welfare; and the Department of Housing and Urban Development.

To be administered by the Building Research Division, the project will use four approaches to lay a foundation for greater certainty, precision, and speed in the financial blueprinting of new construction. These approaches are:

(1) The creation of a standard construction costing language that will allow free interchange of cost experience and cost data among all Federal agencies. At the present time, such free interchange is inhibited by varying usage of common terms.

(2) Tests of the usefulness and industrial feasibility of bidding lump-sum contracts by permitting the use of owner-certified bills of materials to generate unit-price information not now available. Although certified bills of materials as part of the bidding procedure are used today in England and Scandinavia, and a form of this method is used in U.S. road construction, the practice is not now sufficiently applied in the building industry to obtain unit-price information for systems and subsystems with known, tested performance characteristics.

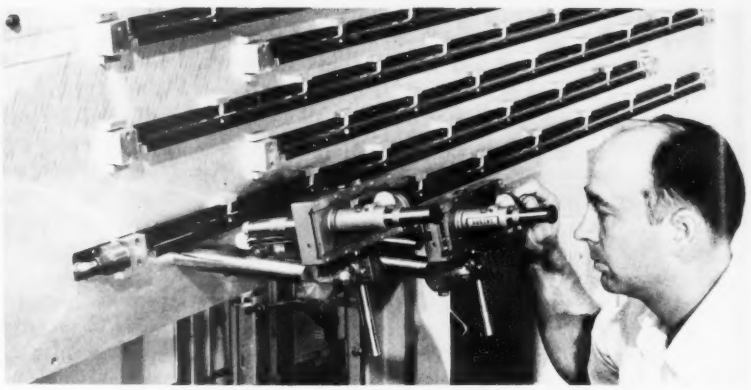
(3) The development of an information handling system that will relate the costing language and industry-generated unit prices for use by people in various steps of the building process (such as requirements, programming, design, and construction).

(4) The standardization of a building operation and maintenance language that will relate construction cost to the life cost of the building.

NBS is conducting the program with the aid of a number of consulting firms. Eventually, the cost system approach will also be applied to performance specifications.

FLUID MECHANICS BUILDING COMPLETED

THE ADDITION OF A FLUID MECHANICS BUILDING completes the original plan for a modern National Bureau of Standards research complex. This building is the twentieth primary structure to be erected on the Bureau grounds at Gaithersburg, Md., and marks the end of 8 years of construction. The Fluid Mechanics Building together with the already completed special and general purpose laboratories provide the modern facilities needed by NBS to keep abreast of measurement requirements demanded by space-age technology. The new laboratory will be used for programs in fluid meters, aerodynamics, and hydraulics.



N. E. Mease at the control panel of the subsonic wind tunnel. The wind tunnel has adjustable walls that allow control of the pressure distribution. Manometer sections on the panel are used to measure pressure.

Fluid Meters

The fluid-meters program, dealing principally with water, liquid hydrocarbons, and air, is concerned with developing and applying improved flow-rate measurements, transfer standards, and flowmeter theory. One large laboratory contains facilities for measurement research and calibration of large air and water meters. Air flow-rate measurements from about 0.1 to 4 pounds per second will be investigated with filtered, dried air at pressures up to about 125 pounds per square inch (1 psi=6894.7 N/m^2). Filtered, treated water will be drawn from a 60 000 gallon reservoir at rates up to about 10 000 gallons per minute and pressures up to about 70 psi for rate measurements using special weighing scales and load cells.

Other laboratories will be used for lower air and water flow-rate measurements as well as for flow measurement and control of liquid hydrocarbons. One special air-flow laboratory is equipped for rate measurements down to a few cubic centimeters per minute and is temperature controlled for accurate measurements.

In the hydrocarbon-flow laboratory, equipment will be available initially for the accurate calibration of liquid-hydrocarbon flowmeters at rates up to 200 gallons per minute and for experimental work on calibration and adjustment procedures for aircraft engine-fuel control units. Space and liquid storage facilities are also provided for the future extension of liquid hydrocarbon flow measurement and control to a rate of about 3000 gallons per minute.

A small digital computer will be applied to the automatic calibration of jet-engine fuel controls. Test input parameters to be controlled and scheduled by the computer include control of fuel supply and drive shaft speed, and simulated engine burner pressure. Also, readout of discharge flow rate from the unit being calibrated will be possible. To increase the effectiveness of an automated approach to these calibration tests, special diagnostic computer programs concerned with fuel-control performance are planned.

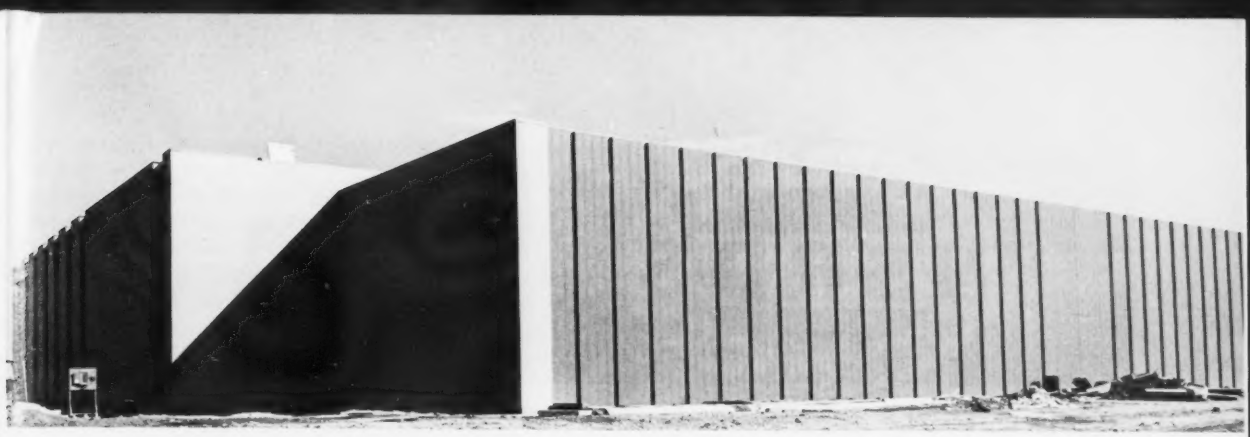
Ventilation equipment in the hydrocarbon-flow laboratory provides a complete air change every two minutes. All electrical components and wiring conform to Class I, Group D specifications for hazardous vapor locations, and a nonsparking tile floor provides an additional safety feature.

Aerodynamics

The aerodynamics program consists of carefully selected basic research projects that are coupled to the development of techniques and instrumentation for the measurement of laminar and turbulent flows at subsonic and supersonic speeds. A direct service to government and industry is also provided by the calibration of wind-speed measuring instruments in the range from 2 to 150 miles per hour. The aerodynamics measurements program is, in part, directed toward improving these activities.

The broad-based program of research into the properties of laminar and turbulent flows will cover a wide range of parameters and flow configurations. Such problems as the transition from laminar to turbulent flows in boundary layers, isotropic turbulence, and turbulence in boundary layers, wakes, and jets will be studied.

Apparatus for these activities will consist of a newly designed and constructed low-turbulence subsonic wind tunnel, a small supersonic tunnel that is being moved from the



Fluid Mechanics Building, the twentieth primary structure erected at the Bureau's Gaithersburg, Md., site, completes the original plan for a modern NBS complex.

Washington site, and open laboratory space for erecting special flow configurations.

The subsonic wind tunnel (replacing two existing wind tunnels on the Washington site) has been especially designed for basic research in aerodynamics and for the calibration of wind-speed measuring instruments. The new tunnel is equipped with two test sections. One, to be used for aerodynamics research, is a 5- by 7-foot section, 40 feet long, with a maximum airspeed of approximately 100 miles per hour. The walls of this section are adjustable, allowing control of the pressure distribution. The other, a calibration test section, is 4- by 5-feet in cross section, 10 feet long, with a maximum airspeed of approximately 150 miles per hour. The two test sections can be readily interchanged with minimum interference to experimental set-ups.

The supersonic tunnel has a 3- by 4-inch test section with a capability of Mach 2 and can be operated over a range of pressures from one-third to three atmospheres. A major activity for the supersonic tunnel is the investigation of problems associated with the transition from laminar to turbulent flow in boundary layers. One objective of this work, for example, is directed toward a fundamental insight into the role played in the transition process by the wall boundary layers.

Hydraulics

The hydraulics program occupies about 2600 square feet of laboratory space for basic hydrodynamics research, hydraulic measurements research, and calibration of water-velocity measuring devices. At the Washington site water-current meter ratings were done in a towing tank, but they will be accomplished in the new building in a water tunnel. For the time being, the calibrations will be performed in a temporary open-circuit water tunnel, which uses as its return leg the 60 000 gallon underfloor reservoir.

At an early date, it is planned that this temporary installation will be replaced by a permanent closed-circuit water tunnel with a 24-inch diameter test section featuring low turbulence and a velocity range of 0-40 feet per second. This tunnel will be a major research facility. It will be designed to permit, for example, research on turbulence and boundary layers in water flow at high Reynolds numbers, as well as providing for calibrations of current meters and other velocity measuring instruments over a wider range of velocities than is now possible.

In addition to the water tunnel, other facilities in the building will be used for both the hydraulics measurements and hydrodynamics research programs. Included in these projects will be an investigation of the flow of dilute drag-reducing polymer solutions in tubes and the associated measurement problems. Also, a general purpose tank 40 feet long, 3 feet wide, and 2 feet deep will be available for research in surface waves, stratified flows, and internal waves.

A Baltimore Local 438 steamfitter installs equipment in the new Fluid Mechanics Building.

NSRDS NEWS

The NSRDS was established to make critically evaluated data in the physical sciences available to science and technology on a national basis. The NSRDS is administered and coordinated by the NBS Office of Standard Reference Data.

The Information Analysis Center and the Creation of Reliable Data

The following material was presented by L. J. Kieffer, Director, Joint Institute for Laboratory Astrophysics Information Center, Boulder, Colo., to the National Academy of Sciences, Office of Critical Tables Advisory Board Meeting, November 18, 1968. It is printed here because it focuses on a major problem facing data evaluators.

There have been, in the past, basically two kinds of Information Centers. The first is the scientific abstracting service, which covers the formally published literature of a scientific discipline. It deals in the raw information of science. The second type is usually represented by the lone scholar, with a small amount of clerical help, sifting through the literature, consulting colleagues and then preparing a critical-data compilation, which he occasionally updates.

Recently, a new and radically different organization has entered the field. There seems to be general agreement that it should be called an Information Analysis Center; the centers operated by the Atomic Energy Commission in the area of nuclear science are good examples. Information Analysis Centers are composed of scientifically-trained scholars, who together with their supporting staffs, sift through and evaluate data reported in the scientific literature, and in some cases, unpublished data. The principal products of this effort are publications of critically-evaluated property data. The most successful of these centers appear to be those embedded in or working very closely with an active research group in their area of interest. In spite of the increasing interest in critical evaluation of data and in the production of reliable data, there exists a difficult intellectual problem which apparently has not been recognized by the critical evaluators, or by scientists in general. In what follows, I will attempt to outline this problem and to make some suggestions about how we might approach a solution.

When I first became involved in information analysis I, of course, floundered about for a time, but when I finally felt that I knew what I should be doing, I ventured out to meet my new colleagues. At that point I was sure there must be a semantics problem, because different evaluators were attaching different meanings to the same words. Later, I came to the conclusion that there was an even more basic problem. A majority of the people trying to critically evaluate property data did not recognize the paramount importance of systematic errors in assessing the reliability of the data. Their typical reaction to needling on this point was, "Well, yes, but nothing can be done about that." Any critical evaluation of data which does not primarily concern itself with the systematic errors inherent in the measurement techniques cannot be productive in the long run.

Far too much of what now passes for critical evaluation consists in applying superficial criteria, e.g., Does the author quote the correct references? Is his presentation clear? Does he use the correct formulas when reporting statistical errors?, etc. At a 1966 Gordon Research Conference on Numerical Data of Science and Technology; Its Compilation and Critical Evaluation, a two-page list of this type was seriously proposed as the author's criteria for obtaining reliable data. It was a beautiful check list for the preparation of a first-rate scientific article but it had precious little to do with the reliability of the data reported. Please don't misunderstand me—I do not want to disparage attempts to improve the style of writing in scientific papers; any improvement in presentation would be a godsend to those of us who actually have to read them. The basic difficulty seems to be that authors never really say, in simple declarative sentences, just what they have done. They make up a story, to go along with the reported measurement, which they hope will convince the journal editor that their paper contains some new physics (or whatever science). Too often they lavish their literary talent on the "story" and hardly discuss the measurement at all.

Where does this leave the reader? Having studied several thousand scientific articles in the past few years, I

have to conclude that it is almost impossible to evaluate the reliability of property data (or any other kind, I imagine) from what is being reported in the scientific literature. At the JILA Information Center, for example, we have found that often important information necessary to evaluate the measurement is missing from the formal published record. This almost certainly guarantees that the measurement will have to be repeated in order to obtain a reliable value.

Before going further, I should make a few general comments about the role of random errors. As we know, there are some rather elegant mathematical theories to handle the random fluctuations that are inherent in every measurement. These ideas are particularly useful in noting when systematic errors are occurring. The researcher can get some real feeling for what is a reasonable deviation from a previous measurement. On the other hand, our real enemy is the systematic error. My own experience, and that, I think, of every scientist who has seriously considered it, has been that statistical error bars are almost never significant in determining the reliability of a measurement.

This point was well stated a few years ago by W. J. Youden, then a member of the National Bureau of Standards, in his paper "Systematic Errors in Physical Constants," which appeared in *Physics Today*.[1] (I hope Dr. Youden will forgive me for quoting him out of context and using him as a "hostile witness.") He said: "When two laboratories make independent determinations, each may attach to its 'best' value a $\pm$ sign followed by an estimate S of the error. This estimate of the error is often based upon a series of observations made under carefully controlled conditions. Experimenters soon discovered that if laboratories A and B reported values C_A and C_B for the same constant, the difference $\triangle$ between C_A and C_B was almost always a large multiple of their estimated error. Obviously these calculated errors had no more to do with the real errors than the neatness of the laboratory or the promptness with which the investigator answered his mail."

Determining the reliability of a measurement is not a simple problem, as anyone who has tried to do a fundamental constant measurement knows. It is clear that we *have* made progress in making measurements more reliable, but it is not easy. The kind of effort which has been lavished on fundamental standards and on constants measurements is the kind of effort necessary to achieve reliability in the measurement of physical properties.

Let me define more precisely some of the terms I am using. Every experiment which purports to quantitatively measure a property of a well-defined physical system is based on a theory. This theory usually consists of a number of mathematical expressions which explain how to connect the dial readings of the instruments to the value attached to the property. For completeness, include in this scheme whatever theory is necessary to connect the instrument with the fundamental standards or secondary standards. In addition, there are a number of stated or unstated assumptions about effects which in principle may affect the measured value but are assumed to be negligible. I would define a reliable experiment in this way: *A reliable experiment is one for which all known sources of systematic error have been delimited and their magnitudes properly assessed.* This includes effects noted in the formal theory for the experiment and in the stated or unstated assumptions. Data resulting from such an experiment I would call *reliable data.* This is the best that can be done. It is, of course, a provisional judgment which can be overturned. If, on the other hand, the above definition does not hold true, then the theory for the experiment is defective; the data and associated error bars are a guess.

Recently I received an inquiry from a university professor about some ionization cross-section data. He had found several numbers in the literature for a certain cross section and he asked my opinion. I reviewed the measurements and noted that *in every instance* the techniques used in making the measurements were defective. I had to reply that any opinion about them was therefore a guess, and his guess was as good as mine.

It is unfortunate, but true, that the vast majority of data compilations made in the past have suffered from the fact that they were attempts to critically evaluate data from defective experiments and therefore they relied on superficial criteria of evaluation. I don't believe anyone should be shocked by the notion that there are many properties we cannot measure reliably and that we have been guessing. This implies that there is probably very little reliable property data available, which is certainly true in my own field of atomic collisions, and probably true outside it (in this case I am guessing, if you'll forgive me).

The criticism I have leveled at past attempts to provide reliable data does not mean that these efforts have not been useful in furthering science and technology. On the contrary, they have been extremely useful. But our measurement techniques (and our knowledge of what constitutes a valid measurement) are advancing at such a rapid rate that our concept of how to compile, evaluate, and disseminate reliable data must change. In fact, we must now create a system which will be a source for reliable data. An archival record must be created in which enough published evidence exists for the user to determine whether a new measurement can be made which would improve their accuracy, and if not, what the accuracy is, based on the clearly stated theory of the experiment. Science and technology have, in the past, taken a rather relaxed attitude toward the problem of reliability. They have assumed that as knowledge and consequently measurement techniques have advanced, new, better measurements could easily be made and a lot of effort should not be expended on learning what is wrong with poor techniques. This assumption is no longer valid.

The dilemma facing not only the critical compiler but also the average scientist in attempting to evaluate the material he finds in the literature is clearly illustrated by the case of two published measurements of ionization cross sections for electron impact on atomic helium. Techniques which had been abandoned for about 35 years were updated by two different laboratories. Several years of effort were expended in each laboratory, using large staffs of Ph. D.'s and modern equipment. The results reported by the two differed by about 25 percent and, of course, their quoted errors were almost a factor of ten smaller. The knowledge of defects in measurement techniques have in general been passed down from teacher to student and not documented. I think the folly of this is well illustrated in this instance. Careful evaluation [2] including discussions with the authors did not yield a convincing case for either measurement. Unfortunately, the formal record of these experiments does not contain enough critical discussion of the measurement techniques to point the way out of the dilemma.

Many readers will conclude at this point that the situation must be pretty bad in atomic collision physics, but of course in their area (solid state, nuclear, etc.) things are in much better shape. From my own experience and from discussions with other compilers, I would say that it is a quite universal phenomenon, although the magnitude of the discrepancies between independent measurements will differ.

I would like to propose that the Information Analysis Centers can be a key tool in the solution of this problem, since they are already deeply involved in evaluation activities and have the staff and resources capable of handling large volumes of data and information. As a first step, the centers, using their own staff and expert consultants, must publish critical discussions of measurement techniques in order to make it clear to the scientist making the measurements which techniques are defective. Second, they must establish and publish objective criteria for judging data so that a consensus can be reached regarding these criteria. And finally, they must publish compilations of reliable data based on the consensus about the reliability of the measurement techniques. Publication of critical discussions of measurement techniques is not consistent with the editorial policy of most scientific journals. In cases where a qualitative conclusion is being drawn it may be that discussions of the measurement techniques can be held to a minimum. It is true, though, that the vast majority of measurements reported in the literature are quantitative and of relatively high precision (3 or more significant figures given).

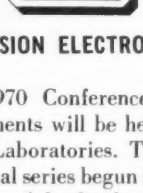
Separate journals devoted to critical discussions of measurement techniques are probably not the answer in all cases and in principle it is difficult to separate the technique from the measurement itself. Whatever the mechanism, it is clear that adequate publication media are needed for such material.

The attitude of the scientists will pose a real problem in implementing the kind of program I have outlined for an Information Analysis Center. Scientific scholarship of the highest order is required for this work, but at present physical scientists do not regard evaluation of the work of others as an acceptable scientific career in itself. This is reflected in the small number of critical evaluations published in the physical sciences. (In the area of critical evaluation of measurement techniques the number is almost zero.) We need a publication medium whose quality will make it acceptable to the scientific community so that working scientists will contribute to it, but what is even more important, the working scientists must participate in reaching the consensus necessary for its success.

Most data compilations in the past have lacked a documented consensus about the reliability of the measurement techniques. The absolutely necessary connection between the reliability of the measurement techniques and the reliability of the data obtained must be generally recognized. A consensus about the reliability of the measurement techniques must be reached and fully documented. Only then can reliable data compilations be produced.

[1] Youden, W. J., Systematic errors in physical constants, Phys. Today 14, 32 (1961).

[2] Kieffer, L. J., and Dunn, G. H., Electron impact ionization cross-section data for atoms, atomic ions, and diatomic molecules: I. Experimental data, Rev. Mod. Phys. 38, 1 (1965).



STANDARDS AND CALIBRATION

PRECISION ELECTROMAGNETIC MEASUREMENTS

The 1970 Conference on Precision Electromagnetic Measurements will be held June 2–5 at the NBS Boulder (Colo.) Laboratories. This is the seventh conference in the biennial series begun in 1958.

The aim of the Conference is to advance electromagnetic measurements at levels of precision and accuracy appropriate to national standards laboratories. The traditional fields of direct current, low frequency, high frequency, and microwave measurements together with related physical studies provide the core of the Conference subject matter. The rapidly developing field of precise measurements at very low temperatures will be emphasized. Methods for automated measurements will also receive special attention.

As in the past, the Conference encourages international participation. In recognition of the importance of this aspect, a special session will be devoted to the international comparison of standards.

The Conference is sponsored by the NBS Institute for Basic Standards, the IEEE Group on Instrumentation and Measurement, and the U.S. Commission 1 of the International Scientific Radio Union (URSI).

Original papers in the following areas will be considered: direct current and low frequency measurements, time and frequency, radio frequency and microwave measurements (including coherent optical techniques), time domain measurements (pulse measurements through the entire electromagnetic spectrum), automated measurements, and cryogenic electromagnetic measurements. Papers should be submitted to the Chairman of the Technical Program Committee:

Dr. Gernot M. R. Winkler
U.S. Naval Observatory
Washington, D.C. 20390

Six copies each of a summary and abstract should be included. The summary of 500-1000 words may include up to five illustrations and will be reproduced in the program digest. (Upon acceptance of papers, detailed instructions of summary preparation for photoreproduction will be mailed to the author.) The abstract, to be printed in the advance program, should contain no more than 200 words and no illustrations. The deadline for receipt of abstracts and summaries is February 6, 1970.

Conference papers will again be published in a Special Issue of the *IEEE Transactions on Instrumentation and Measurement*. Three copies of the complete manuscript including original illustrations will be accepted during the Conference for review and possible publication in this Issue.

The Bureau of Continuation Education of the University of Colorado will handle the local arrangements. General questions concerning the Conference should be addressed to:

George Goulette
Bureau of Continuation Education
University of Colorado
Boulder, Colo. 80302

STANDARD FREQUENCY AND TIME BROADCASTS

High-frequency radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast time signals on the Coordinated Universal Time (UTC) system as coordinated by the Bureau International de l'Heure (BIH), Paris, France. These NBS time signals, UTC (NBS), are maintained within 5 microseconds of the corresponding time signals of the U.S. Naval Observatory, UTC(USNO). The UTC pulses occur at intervals that are longer than one coordinate second by 300 parts in 10^{10} during 1969, due to an offset in carrier frequency coordinated by BIH. To maintain the UTC scales in close agreement with the astronomers' time, UT2, phase adjustments are made at 0000 hours Greenwich Mean Time (GMT) on the first day of a month as announced by BIH. *There will be no adjustment made on November 1, 1969.*

The low-frequency radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses without offset to make available to users the standard of frequency so that absolute frequency comparisons may be made directly, following the Stepped Atomic Time (SAT) system. Step time adjustments of 200 ms are made at 0000 hours GMT on the first day of a month when necessary. BIH announces when such adjustments should be made in scale to maintain the seconds pulses within about 100 ms of UT2. *There will be an adjustment made on November 1, 1969. The seconds pulses emitted from WWVB will be retarded 200 ms.*

NBS obtains daily UT2 information from forecasts of extrapolated UT2 clock readings provided by the U.S. Naval Observatory with whom NBS maintains close cooperation.

FREQUENCY AND TIME PUBLICATION REVISED

The 1969 edition of *NBS Frequency and Time Broadcast Services—Radio Stations WWV, WWVH, WWVB, and WWVL*,[1] NBS Spec. Publ. 236 (14 pages, 25 cents), has recently been published. It describes the eight vital broadcast services NBS provides through its radio stations WWV, WWVH, WWVB, and WWVL. The eight services are: standard radio frequencies, standard audio frequencies, standard musical pitch, standard time intervals, time signals, UT2 corrections, radio propagation forecasts, and geophysical alerts.

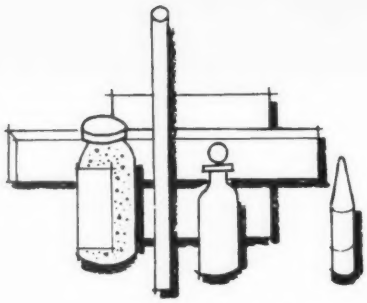
To provide users with the best possible services, occasional changes in broadcasting schedule are required. NBS Spec. Publ. 236 is revised annually to reflect these changes. This edition shows the schedules in effect on January 1, 1969.

The major development of the past year affecting the accuracy of the NBS broadcasts was the introduction of an improved method for coordinating the master clock at Fort Collins, Colo., with the atomic clock at the NBS laboratories in Boulder.[2] This new method makes use of broadcasts from local TV stations, which become key elements in the chain of controls for the precision and accuracy of NBS standard frequency and time broadcasts. With this new system the clock that controls the broadcasts from station WWV in Fort Collins may be kept within one millionth of a second of the atomic clock in Boulder.

[1] Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.

[2] For further details, see Commercial television aids NBS standard broadcasts, Standards and Calibration, Nat. Bur. Stand. (U.S.), Tech. News Bull. 53, No. 5, 111 (May 1969).

STANDARD REFERENCE MATERIALS



INTERNATIONAL STANDARD REFERENCE MATERIALS SYMPOSIUM

Representatives from 15 countries and 4 international agencies met at NBS May 26–28, 1969, to explore the possibilities and the problems of establishing an international standard reference materials program.

Those organizations responsible for producing and certifying Standard Reference Materials (SRM's) have become increasingly aware of the need for international cooperation to prevent wasteful duplication of effort and to meet the world's needs for SRM's. This Symposium was proposed in 1968 by A. V. Astin, then NBS Director, and was cosponsored by NBS and the International Committee on Weights and Measures (CIPM).

Dr. Astin opened the Symposium, and J. M. Otero, CIPM President, briefly described the role of CIPM. The Symposium's background, purpose, and scope were set forth by W. W. Meinke, Chief of the NBS Office of Standard Reference Materials.

Dr. Meinke pointed out that as mankind depends more on instruments and machines to help in his quest to control the environment and utilize its resources, the demand rapidly increases for meaningful measurements that contribute to the development and control of these instruments and machines.

The Treaty of the Meter of 1875, which led to the establishment of CIPM, provides the ultimate basis for compatible measurement throughout the world. Scientific and technological advances have required significant changes in the nature and scope of the activities covered by the Treaty. Nevertheless, instrument calibration, through a pyramidal network terminating at the International Bureau of Weights and Measures (BIPM), remains the primary means of achieving compatibility of measurement. Loss of accuracy at different calibration levels and delays and inconveniences in shipping instruments to calibration centers are the disadvantages of this system.

The use of SRM's is another effective means of providing measurement compatibility. SRM's provide reference points for calibrating instruments via the certified physical or chemical property of the material and, by permitting *on site* calibration, SRM's eliminate time-consuming shipping of equipment to calibration centers.

Each nation and agency representative attending the Symposium reviewed the status of his agency's SRM program. Certain countries, among them the Federal Republic of Germany, Japan, the United Kingdom, and the United States, have fairly comprehensive SRM programs now underway, although delegates from these countries stressed apparent gaps and omissions in their programs. That there is an international need for those SRM's already available is borne out by the fact that the NBS currently distributes well over 25 percent of its SRM production to other nations. Germany, Japan, and the United Kingdom have similar distribution patterns.

Several other nations, the Union of South Africa, Canada, France, Spain, Netherlands, Czechoslovakia, and the international agencies, EURATOM and the International Atomic Energy Agency, have smaller and more specialized SRM production than the countries previously mentioned. Nevertheless, in their special fields, international interest and distribution of these available SRM's were also evident.

Most of the other nations present, Australia, Korea, India, Italy, Norway, and the remaining two international agencies, IUPAC and BIPM, have only very limited or no SRM programs underway. These nations depend almost entirely on other sources for SRM's.

The delegates generally agreed that while many important segments of world industry and technology are being adequately served by SRM's presently available—though international distribution is often a problem—a multitude of needs are not being met. In the U.S. alone, well over 200 specific SRM needs have been identified that will not be met in the near future. Furthermore, it was generally agreed that no one nation could possibly fill the world's needs for SRM's, as the resources necessary to meet these needs with the desired promptness exceed those of any single nation.

The primary cost of preparing SRM's lies in the preparation of the material and in the certification of its composition of properties. Hence, a large quantity of a particular material type can usually be prepared at only slightly higher cost than a small quantity. This means that significant economies could be achieved if SRM's were prepared for a world market rather than a national market. If several nations cooperate in the shared development and distribution of SRM's, more of the needed materials would be available for science and technology throughout the world. An additional advantage of an international SRM program is that the special competence

of the different nations could be shared both in materials preparation and in materials characterization with resulting benefits to all.

Some of the anticipated technical problems of an international SRM program that were discussed included such examples as the exchange of information on SRM's among nations, the proper role and use of SRM's, and identifying SRM needs for industrial and developing nations.

Other major points raised and discussed were:

1. There is a need for a central distribution point for the exchange of information through an international organization.

2. An international SRM vocabulary is required.

3. There is an immediate need for a catalog or list of SRM's now available.

4. Available SRM's in some instances and between certain countries do not move freely or without serious complications involving licenses, duties, currency restrictions, and language.

5. There are serious differences in the current price levels of SRM's now available; there is no criterion at present for relating quality and price.

6. Barter of SRM's between countries is not feasible for all countries; in some cases there are legal barriers against such practices.

7. An international questionnaire is urgently needed to gather information on such questions as levels of accuracy required, identification of SRM needs, priority of identified needs, SRM's presently available, and resources available for producing and certifying SRM's.

8. Can a procedure be established so that when an SRM is to be produced in a particular country extra material can be made available to other countries for certification by those countries?

Discussion of these points showed that most of the problems could not be resolved in the time available, nor did many of the delegates feel they had the requisite authority to bind their countries to such widespread action as would be necessary to initiate a broad international SRM program. It was therefore decided to limit the conference to actions and recommendations that would be achievable.

The following questions were then raised, discussed, and formally voted on.

1. Is a continuing international exchange of information on SRM's desirable?

2. Should this exchange be coordinated through an existing international agency or agencies?

3. Which existing international agency is the most appropriate for coordinating this information exchange?

4. Should this agency be asked to provide continuing Secretariat services for the exchange among countries of information such as catalogs, technical and scientific brochures, pamphlets, and price lists on present SRM programs and on plans for the future?

5. Should this agency also be asked to coordinate information on the unfulfilled needs of different countries for SRM's?

6. Should this agency also be asked to coordinate information on potential suppliers for unique materials suitable for SRM's?

7. Should this agency be asked to coordinate information on potential certifying facilities for SRM's?

On questions 1, 2, 4, 5, 6, and 7 the response was almost unanimously affirmative. On question 3, BIPM was chosen overwhelmingly as the most appropriate international agency.

Finally the delegates unanimously agreed to request that as the ISRM (International SRM) Program develops, BIPM be alert to opportunities for international cooperation in the technology of SRM's.

In a summary statement, Dr. Astin agreed with the opinion expressed by many delegates that certification of SRM's internationally would be a time-consuming process but suggested two possible routes to accelerate the process. First, the CIPM Advisory Committees should develop and provide guide lines to assure the quality of certification for any proposed international SRM, and second, through the same mechanism, round-robin techniques could be initiated to assess and, where necessary, promote the quality of the certifying work of participating laboratories.

In his summary W. W. Meinke pointed out the importance for each delegate to disseminate within his own country or agency the findings and recommendations of the Symposium and, furthermore, to help develop national information systems that could then be responsive to the BIPM's requests for information.

J. M. Otero stressed the importance for each delegate to contact his official CIPM representative to ensure that he has full knowledge of the Symposium's findings and recommendations.

J. Terrien, BIPM Director, read from a statement he made in 1962 in which the role and scope of responsibilities of BIPM were defined. In that statement he said, ". . . it seems clear that the reason for the existence of the BIPM is and will remain, as at its inception, to concentrate its action on these points of departure in order to secure the uniformity of measurement in the world and to improve their quality." Later in the statement he said that BIPM should resist the natural tendency to disperse its actions toward secondary measurements, *but* not at the expense of seeking out new points of departure which are more precise and more universal. He recognized, as a result of the Symposium proceedings, the universal need for more, and more accurate, SRM's and that the problem facing BIPM would be to discover how and with what measures these needs could be filled. He assured the delegates he would do all in his power to secure a favorable conclusion, but stressed that, as BIPM was created by and under the control of member nations, these nations would decide the role BIPM could accept.

CONFERENCE & PUBLICATION Briefs

IMAGE STORAGE AND TRANSMISSION FOR LIBRARIES

A Conference on problems and prospects for image storage and transmission systems for library applications will be held at the Bureau's Gaithersburg, Md., site on December 1–3, 1969. Cosponsors of the Conference will be the Federal Library Committee's Task Force on Automation, the Lister Hill National Center for Biomedical Communication, the Panel on Information Sciences Technology of COSATI*, and NBS.

The program will examine the development and use of graphic and textual image transmission systems, as well as the state of the advancing technology in equipment and techniques for such systems. Invited speakers will present underlying principles of the subject along with their appraisal of the more important aspects of applications. The technical sessions will include such topics as:

Survey of Transmission Systems
Operational Practice and Constraints
Microimage Storage and Transmission
Advanced Techniques in Image Transmission
Legal and Economic Problems

A copy of the *Proceedings*, in microfiche form, will be mailed to each registrant following the Conference.

For further information, contact Madeline M. Henderson, Center for Computer Sciences and Technology, National Bureau of Standards, Room B226-Instr., Washington, D.C. 20234.

RADIATION DETECTORS

The latest developments in nuclear radiation detectors, and their applications, will be discussed at the 12th Scintillation and Semiconductor Counter Symposium, March 11–13, 1970, at the Shoreham Hotel in Washington, D.C. Sponsors of this symposium are the IEEE Nuclear Science Group, NBS, and the Atomic Energy Commission.

The fields of interest that will be covered include scintillation and fluorescence phenomena; photomultipliers; semiconductor detectors; other types of detectors of ionizing radiation; track imaging, spark and proportional counters; proportional position sensitive detectors; biomedical detectors; spectrometry; signal conditioning circuits; low noise preamplifiers; space applications; x-ray spectroscopy and detection; and detector array and data handling.

The program includes both invited papers and contributed papers. The deadline for submission of abstracts is November 15, 1969.

Heading the list of special events is the banquet address to be delivered by P. R. Bell, Manager of NASA's Lunar Receiving Laboratory. He will discuss nuclear analysis of lunar samples including those obtained by the Apollo 11 crew. The invited papers include one by Robert Hofstadter of Stanford University (1961 Nobel Laureate in Physics) who will describe total absorption detectors for high energy physics. George T. Reynolds of Princeton University will discuss x-ray diffraction image intensifiers, while Louis Koester, Jr., of the University of Illinois will present a paper on wire proportional arrays. James W. Mayer of the California Institute of Technology will review work on cadmium telluride and trapping phenomena in semiconductor radiation detectors. New methods and techniques in particle detection at high energies will be the subject of a paper by Arthur Roberts of the National Accelerator Laboratory. An added attraction will be a manufacturer's exhibit displaying the latest developments in nuclear instrumentation.

Further information may be obtained by contacting either R. L. Chase, Chairman, Program Committee, S.S.C.S., Bldg. 535, Brookhaven National Laboratory, Upton, N.Y. 11973, or Louis Costrell, Chief, Radiation Physics Instrumentation Section, National Bureau of Standards, Washington, D.C. 20234.

MASONRY CONFERENCE TO MEET

Performance of Masonry Structures is the theme of a Conference to be held at the Bureau's Gaithersburg, Md., site March 16–18, 1970. The Conference will be jointly sponsored by NBS, the National Concrete Masonry Association, and the Structural Clay Products Institute.

During the past five years there has been a significant increase in the structural use of masonry. This National Conference, the first to be jointly sponsored by the national masonry trade associations and NBS, will provide a comprehensive review of current aspects of masonry research, design, and construction. Formal presentations and open discussions will permit an exchange of data and information of interest to architects, engineers, con-

*COSATI—Committee on Scientific and Technical Information, Federal Council for Science and Technology.

tractors, building owners, and material manufacturers.

Sessions during the three-day Conference will be devoted to Creativity in Masonry, Material Properties and Specifications, Current Research Programs, Codes and Standards, Case Studies of Bearing Wall Buildings, Miscellaneous Structures, Construction, and Prefabrication. The program will also include a tour of NBS laboratories.

The Conference is open to all interested persons. Further information can be obtained from Robert Dikkers, Room B-160, Building 226, National Bureau of Standards, Washington, D.C. 20234.

SPACE SIMULATION CONFERENCE

A three-day Space Simulation Conference will be held at the NBS site in Gaithersburg, Md., September 14–16, 1970. This meeting, the fifth in an annual series, reflects the joint interests of the American Institute of Aeronautics and Astronautics, the Institute of Environmental Sciences, and the American Society for Testing and Materials. The following committees from the sponsoring societies are participating: AIAA Technical Committee on Ground Testing and Simulation, AIAA Technical Committee on Thermophysics, ASTM Committee E-21 on Space Simulation, IES Committee on Solar Radiation Simulation, and IES Committee on Vacuum. ASTM is responsible for the 1970 meeting, with the assistance of NBS.

The purpose of the Space Simulation Conference is to provide a forum for presentation of new information on the technology of space simulation. This technology area encompasses all aspects of simulating and determining the effects of the many environmental features of space; e.g., vacuum, solar radiation, particle radiation, meteoroids, weightlessness, magnetic fields, temperature extremes, planetary atmospheres, reentry, and others. Topics of interest include simulation requirements; simulation facilities; personnel and equipment safety in facility operations; simulation techniques and test methods; behavior of materials, components, systems, and spacecraft in simulated environments; evaluation of simulation methods using flight results; scaling in space simulation tests; facility instrumentation and data acquisition systems; and other topics which deal with the technical aspects of space simulation. Also within the scope of the conference are problems dealing with man-rating space simulation facilities and the interaction of man and manned spacecraft with the simulative environments, such as the toxicity and flammability of materials.

It is hoped that a portion of this year's meeting will be devoted to the simulation challenges posed by the long duration unmanned earth and interplanetary missions and manned space stations planned for the future. Therefore, papers are especially solicited that present space simulation requirements, approaches, and results that contribute to the technology required to accomplish these missions. Subjects such as long-term environmental effects; accelerated testing; prediction of long-term effects from short, real time testing; simulation of environments in their true sequence; the need for in situ measurements; and contamination of spacecraft during ground testing and flight are particularly pertinent.

Although certain subjects have been suggested, papers presenting significant results on other subjects within the broad scope of the conference will be considered. The conference format will include invited papers as well as those submitted in response to this call. All papers must be unclassified.

Abstracts of 500 to 1000 words covering a proposed paper should be submitted in triplicate by March 2, 1970. Abstracts should be sent directly to the Technical Program Chairman:

Eugene N. Borson
120/2431
The Aerospace Corporation
Box 95085
Los Angeles, Calif. 90045

Papers will be reviewed by the Program Committee and authors will be notified of tentative acceptance or rejection by April 15, 1970. Manuscripts will be required by May 30 for review and final acceptance. Final manuscripts will be due by July 15, 1970. Published proceedings will be available shortly after the conference.

General inquiries or suggestions concerning this meeting should be addressed to the General Chairman:

Joseph C. Richmond
Rm. B126, Metrology Bldg.
National Bureau of Standards
Washington, D.C. 20234.

SCHEDULED NBS-SPONSORED CONFERENCES

Each year NBS sponsors a number of conferences covering a broad range of topics in science and technology. The conferences listed below are either sponsored or cosponsored by NBS and will be held at the Bureau's Gaithersburg, Md., facility unless otherwise indicated. These conferences are open to all interested persons unless specifically noted. If no other address is given, inquiries should be sent to the person indicated below in care of Special Activities Section, Room A600, Administration Building, National Bureau of Standards, Washington, D.C. 20234.

3d Materials Research Symposium—Electronic Density of States. Nov. 3–6. Contact: H. C. Burnett (NBS Metallurgy Division).

Thermodynamic Properties of Fluids. Nov. 5–7. Contact: H. J. White, Jr. (NBS Office of Standard Reference Data). By invitation only.

Conference on Image Storage and Transmission for Libraries. Dec. 1–3. Cosponsors: Federal Library Committee; Lister Hill National Center for Biomedical Communication; COSATI (Panel on Information Sciences Technology). Contact: Madeline Henderson (NBS Center for Computer Sciences and Technology).

Twelfth Scintillation and Semiconductor Counter Symposium. Mar. 11–13, 1970. Cosponsors: IEEE (Nuclear Science Group); Atomic Energy Commission. Contact: Louis Costrell (NBS Center for Radiation Research).

Performance of Masonry Structures. Mar. 16–18, 1970. Cosponsors: National Concrete Masonry Association; Structural Clay Products Institute. Contact: Robert Dikkers (NBS Building Research Division).

1970 Conference on Precision Electromagnetic Measurements. June 2–5, 1970. Cosponsors: IEEE (Group on Instrumentation and Measurement); International Scientific Radio Union (U.S. Commission 1). Contact: George Goulette, Bureau of Continuation Education, University of Colorado, Boulder, Colo. 80302. To be held at NBS in Boulder, Colo.

MATERIALS RESEARCH

Molecular Dynamics and Structure of Solids, NBS Special Publication 301[1] (571 pages, $4) edited by R. S. Carter and J. J. Rush, is the formal report of the Second Material Research Symposium of the NBS Institute for Materials Research. This symposium brought scientists together from the U.S. and abroad to exchange ideas, compare numerical results, and discuss experimental procedures used in studying the basic structural and dynamical properties of molecular solids.

Studying the structural behavior and bonding properties of molecules leads to a better understanding of complex reaction processes. Some of the experimental techniques used to study the structural behavior of molecules through atomic and nuclear properties discussed at the symposium include neutron and x-ray diffraction, neutron inelastic scattering, infrared and Raman spectroscopy, and nuclear magnetic resonance. Five invited papers and 57 contributed papers, in addition to discussions, are incorporated in this symposium report.

ACTIVATION ANALYSIS

Modern Trends in Activation Analysis,[1] edited by James R. DeVoe and Philip D. La Fleur, NBS Special Publication 312, Volumes I and II (Vol. I, 671 pages; Vol. II, 663 pages; $8.50 per set) are the proceedings of the Third International Conference on Activation Analysis, which was held October 7–11, 1968, at the NBS site in Gaithersburg, Md.

The aim of the Conference was to produce a definitive summary of the state of the art of activation analysis as of the fall of 1968. Volume I contains the text of two invited lectures on activation analysis and radiochemical separations. It also has the contributed papers covering applications of activation analysis in environmental sciences, biology, medicine, archaeology, criminology, geochemistry, geology, and industry. Volume II includes the texts of three lectures on nuclear reactions, radiation detectors and data processing, and computation methods in activation analysis. Contributed papers in Volume II deal with these three general topics. Author and subject indexes for the entire Proceedings are given in Volume II.

Each day of the conference began with a "state-of-the-art" lecture on a major phase of the activation analysis technique. In addition, panel discussions were convened at the end of each day in which chairmen of the day's sessions gave synopses of the major points discussed in their particular sessions. The fifteen synopses thus prepared, and the remarks of honored guests, Glenn T. Seaborg, R. E. Wainerdi, and V. P. Guinn, are also included in these volumes.

[1] Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.

PUBLICATIONS of the National Bureau of Standards*

PERIODICALS

Technical News Bulletin, Volume 53, No. 9, September 1969, 30 cents. Annual subscription: Domestic, $3; foreign, $4. Available on a 1-, 2-, or 3-year subscription basis.

Journal of Research of the National Bureau of Standards

Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, $9.50; foreign, $11.75. Single copy price varies.

Section B. Mathematical Sciences. Issued quarterly. Annual subscription: Domestic, $5; foreign, $6.25. Single copy, $1.25.

Section C. Engineering and Instrumentation. Issued quarterly. Annual subscription: Domestic, $5; foreign, $6.25. Single copy, $1.25.

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